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ontario hydro
research division

To: Mr. I.J. Stuart-Sheppard
Manager, Power Equipment
Design & Development Division - Generation
H11A17

TURBINE CAPABILITY TEST
BRUCE 'B' NGS - UNIT 6

D.F. Townshend

The Electrical Research Department assisted the Performance Test Group, Design and Development Division - Generation, by measuring various generator electrical quantities during a 100% reactor power capability test on Unit 6 Bruce 'B' NGS, November 5, 1986. This report describes the electrical instrumentation procedures and contains the final tabulated electrical results of these tests corrected for all metering errors.

1.0 INSTRUMENTATION

1.1 Quantities Measured

Generator Power
Generator Reactive Power
Generator Phase Currents
Generator Phase to Neutral Voltages
Excitation Input Power

Generator operating power factor was determined from measurements of generator power and reactive power.

1.2 Instrumentation Procedures

With the exception of measurement of excitation transformer input power the instrumentation procedures for this test are identical to that used and well documented in turbine acceptance tests, Bruce 'B' Unit 6 (Report No 84-369-H). Updated meter calibrations and instrument transformer correction factors have been applied and copies of calibration reports are attached.

job	file	date	report no.
18-162-401-50	813.11	January 21,1987	86-355-K

1.3 Input Power to Excitation Transformers

This unit is equipped with two independent static exciters requiring that power to both excitation transformers be measured and totalled. Scientific Columbus Digilogic watt/watthour transducers, identical to that used in measuring generator power, were used for this measurement and readings were integrated over a period of five minutes coincident with generator power measurements. Current and potential quantities were supplied from station current and potential transformers.

2.0 ACCURACY OF TEST RESULTS

2.1 Generator Power

The attached watt/watthour transducer per cent registration calibration report EC86-383-K indicates an accuracy of calibration to be ±0.1 per cent. A combined transformer correction factor for metering transformers, Report No EC86-394-K, indicates an accuracy of ±0.1 per cent.

From the above, the combined outside limit of error for Generator Power Measurement is therefore ±0.2 per cent. If the root mean square method of establishing possible errors is used, the test results for generator power measurements are deemed to be accurate to within ±0.14 per cent.

2.2 Generator Reactive Power

Generator reactive power measurement is a derived quantity requiring the use of phase shifting transformers and as such the transformer correction factors for the metering transformers, as listed elsewhere in this report, are not applicable to this measurement. The attached instrument per cent registration calibration report No EC86-384-K for the watt/wattmeter transducer and phase shifting transformers used for this measurement indicates an estimated accuracy of ±0.25 per cent.

2.3 Generator Operating Power Factor

Generator operating power factor is obtained from measurements of generator power and reactive power. As noted previously the outside limits of accuracy for generator power are ±0.2 per cent. The limits of accuracy for generator reactive power are less definite due to the omission of an applicable metering transformer correction factor for this quantity. However, with a unit operating power factor of 0.9 per cent, it would require a combined metering error of 0.4 per cent to produce an error of 0.1 per cent in power factor measurement. Therefore the error in neglecting a TCF factor in computing generator reactive power is small and can be neglected. The estimated outside limits of error for generator operating power factor are ±0.1 per cent.

2.4 Input Power to Excitation Transformers

The attached watt/watthour transducer per cent registration calibration reports EC86-387-K and EC86-385-K indicate an estimated accuracy of calibration to be ±0.1 per cent. However, current and potential quantities used in this measurement were supplied from station metering current and potential transformers, accuracy class 2.5 L 200 and 0.3 Z 120 volt respectively, of which there is no transformer correction factor. From the capability test result, average exciter input power is 1602 kilowatts which represents about 0.2 per cent of gross output power of 936311 kilowatts. Therefore any error in instrumentation calibrations, although unknown, can be considered to have an insignificant effect in calculating net generator power output and has been omitted.

3.0 Test Results

Due to station generation limits and system requirements it was not possible to test at 100 per cent reactor power. A precapability test with reactor power at 95 per cent and the capability test with reactor power at 99.5 per cent are presented in the attached Tables. Listed are dates and times, five-minute test results, averages over the full test period, for gross generator power, reactive power, net generator power, power factor, and excitation input power.

The tabulated values for generator power should be considered to be correct to within the outside limits of error of ±0.2 per cent as listed in Section 2.1 of this report.

Approved:

A.F. Baljet
Manager
Electrical Research Department

Submitted:

D.F. Townshend
Supervising Technologist
System Studies Section

DFT:td

DISTRIBUTION

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BRUCE B NGS UNIT 6
CAPABILITY TEST

REACTOR POWER 99.5% STEAM PRESSURE 4600 KPAG
3 GOVERNOR VALVER FULL OPEN
1 GOVERNOR VALVE 62% OPEN

DATE	GENERATOR OUTPUT			POWER	EXCITER
NOV 5 86	GROSS		NET	FACTOR	INPUT
TIME PERIOD	k watts	k vars	k watts	LAG	k watts
15:00 - 15:05	936800	349471	935201	0.937	1599
15:05 - 15:10	936062	353324	934453	0.936	1609
15:10 - 15:15	936171	356560	934562	0.935	1609
15:15 - 15:20	936268	356535	934661	0.935	1607
15:20 - 15:25	936365	356269	934765	0.935	1599
15:25 - 15:30	936268	353385	934671	0.936	1597
15:30 - 15:35	936147	352524	934552	0.936	1595
15:35 - 15:40	936231	352124	934635	0.936	1596
15:40 - 15:45	936316	352658	934718	0.936	1598
15:45 - 15:50	936244	353130	934642	0.936	1601
15:50 - 15:55	936437	354257	934834	0.935	1603
15:55 - 16:00	936425	354912	934813	0.935	1612
AVERAGE	936311	353762	934709	0.935	1602

BRUCE B NGS UNIT 6
PRE CAPABILITY TEST

REACTOR POWER 95.0% STEAM PRESSURE 4400 KPAG
4 GOVERNOR VALVES FULL OPEN

DATE	GENERATOR OUTPUT			POWER	EXCITER
OCT29.1986	GROSS		NET	FACTOR	INPUT
TIME PERIOD	k watts	k vars	k watts	LAG	k watts
11:00 - 11:05	900183	315564	898750	0.944	1432
11:05 - 11:10	899166	315419	897737	0.944	1429
11:10 - 11:15	898997	316461	897567	0.943	1430
11:15 - 11:20	900618	316740	899184	0.943	1434
11:20 - 11:25	898767	315031	897339	0.944	1428
11:25 - 11:30	899069	315613	897639	0.944	1430
11:30 - 11:35	900897	316376	899463	0.944	1433
11:35 - 11:40	898174	325477	896709	0.940	1465
11:40 - 11:45	900425	337983	898948	0.936	1476
11:45 - 11:50	899348	335377	897864	0.937	1484
11:50 - 11:55	900267	334044	898787	0.938	1481
11:55 - 12:00	899069	329064	897631	0.939	1438
AVERAGE	899634	322679	898187	0.941	1447

Ontario Hydro Research Division

instrument calibration report

to	Mr. D.F. Townshend System Studies Section Research Division
instrument	Watt/Watthour Transducer
serial no.	Lab No 3788
nameplate data	Scientific Columbus Watt/Watthour Standard Model DL34-2K5-A2-6070 5A 120V 60Hz 1500W 3 element 3 phase 4 wire 1 mA dc into 0 to 10 kohm
received from	System Studies Section
date received	November 10, 1986

Calibration by Standard Watthour Meter (SC1) on Balanced Three Phase Load 120 V Phase to Neutral 60 Hz
Ambient Temperature 23 C

Test Current (Amperes)	Power Factor (Lagging)	Percentage Registration
5.5	0.93	99.85

The transducer was connected 3 phase, 3 element, 4 wire.

The percentage registration was based on the digital readout and the time set by the internal interval timer.

The accuracy of the calibration is estimated to be ±0.1 percentage registration.

Approved:	Certified:	Tested:
R.D. Brown	M. Sein	G.L. Grant
Supervising Engineer	Supervising Technologist	Technologist

standards laboratory - electronics and instrumentation section - electrical research department

next calibration scheduled for:	file	date	report no.
—	815.11(P).	November 17, 1986	EC86-383-K

Ontario Hydro Research Division

instrument calibration report

to	Mr. D.F. Townshend System Studies Section Research Division		
instrument	Watt/Watthour Transducer Phase Shifting Transformer	serial no.	Lab No 3961 6392338
nameplate data	1. Watt/Watthour Transducer 1500 Watts = 1500 MV, 1 contact transfer = 1 watt hour 2. VAD Transformer, Volts 120/208, Cycles 60, compensated for 7.5 VA burden		
received from	System Studies Section	date received	November 10, 1986

Calibration by Standard Varmeter on Balanced
Three Phase Load, 120 V Phase to Neutral, 60 Hz
Ambient Temperature 23°C

Test Current (Amperes)	Power Factor (Lagging)	Percentage Registration
5.5	0.93	99.8

The watthour transducer was connected to the VAD transformer and was calibrated as a varhour meter.

The percentage registration was based on the digital readout and the time set by the internal interval timer.

The accuracy of the calibration is estimated to be ±0.25 percentage registration.

Approved:	Certified:	Tested:
R.D. Brown Supervising Engineer	M. Sein Supervising Technologist	G.L. Grant Technologist

standards laboratory - electronics and instrumentation section - electrical research department

next calibration scheduled for:	file	date	report no.
—	815.11(P).	November 17, 1986	EC86-384-K

Ontario Hydro Research Division

instrument calibration report

to	Mr. D.F. Townsend System Studies Section Research Division
instrument	Watt/Watthour Transducer
serial no.	6180 Lab No 4309
nameplate data	Watt/Watthour Transducer, 3 phase, 4 wire, 5 A, 120 V 1500 Watts = 1500 MV, 1 contact transfer = 1 watt hour
received from	System Studies Section
date received	November 17, 1986

Calibration by Standard Watthour Meter (SC1) on
Balanced Three Phase Load at 115 V, 60 Hz
Ambient Temperature 23°C

Test Current (Amperes)	Power Factor	Percentage Registration
1.3	0.5 lag	100.05

The transducer was connected 3-phase, 2-element (red and blue) and the auxiliary supply was energized at 120 V.

The percentage registration was based on the time set by the internal timer, and the digital readout.

The accuracy of the calibration is estimated to be ±0.1 percentage registration.

Approved:	Certified:	Tested:
R.D. Brown	M. Sein	G.L. Grant
Supervising Engineer	Supervising Technologist	Technologist

standards laboratory - electronics and instrumentation section - electrical research department

next calibration scheduled for:	file	date	report no.
-	815.412(P).	November 18, 1986	EC86-385-K

Ontario Hydro Research Division

instrument calibration report

to

Mr. D.F. Townsend
System Studies Section
Research Division

instrument	serial no.
Watt/Watthour Transducer	6177

nameplate data

Watt/Watthour Transducer, 3 phase, 4 wire, 5 A, 120 V
1500 Watts = 1500 MV, 1 contact transfer = 1 watt hour

received from	date received
System Studies Section	November 17, 1986

Calibration by Standard Watthour Meter (SC1) on
Balanced Three Phase Load at 115 V, 60 Hz
Ambient Temperature 23°C

Test Current (Amperes)	Power Factor	Percentage Registration
1.3	0.5 lag	100.06

The transducer was connected 3-phase, 2-element (red and blue) and the auxiliary supply was energized at 120 V.

The percentage registration was based on the time set by the internal timer, and the digital readout.

The accuracy of the calibration is estimated to be ±0.1 percentage registration.

Approved:	Certified:	Tested:
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Supervising Engineer	Supervising Technologist	Technologist

standards laboratory - electronics and instrumentation section - electrical research department

next calibration scheduled for:	file	date	report no.
-	815.412(P).	November 17, 1986	EC86-387-K

ontario hydro
research division

Mr. I.J. Stuart-Sheppard
Manager, Power Equipment Department
Design & Development Division - Gen, H11A27

TRANSFORMER CORRECTION FACTOR
FOR PERFORMANCE TESTS ON
UNIT NO 6 BRUCE GS "B"

G.L. Grant

Transformer Correction Factor (TCF) has been calculated for the metering configuration used during performance tests on Unit No 6 at Bruce GS "B".

The ratio of the generator current transformers (ct) was 21 500 to 5-5 A and that of the voltage transformers (vt), specially installed for the tests, was 14.4 kV - 120 V, (120:1).

The ct were calibrated on site in July 1986 by utilizing the 5 to 5 A test primary. Prior to installation these transformers were calibrated in the Research Laboratory on both the 21 500 to 5 A ratio (one turn primary) and the 5 to 5 A ratio (test primary).

A comparison of the calibrations made in the laboratory and in the field show no significant change in the transformer errors.

The three vt used during the performance tests were calibrated in the Research Laboratory.

The nameplate data and the calibration report numbers for the transformers are listed in Appendix 1.

The TCF listed are directly applicable only to the three-phase three-element energy measurements made during performance tests, and are to be applied at the terminals of the watthour transducer.

Secondary Current	Secondary Voltage	Power Factor	Transformer Correction Factor (TCF)
5.5 A	120 V	0.93 lag	0.9991

The accuracy of the TCF is estimated to be ±0.0010.

Approved:

R.D. Brown
Supervising Engineer
Electronics & Instrumentation Section
Electrical Research Department

Submitted:

G.L. Grant
Technologist
Electronics & Instrumentation Section

GLG:vc

APPENDIX 1

NAMEPLATE DATA

Current Transformers (3)

Canadian General Electric
Type CT ROP
Ratio 21 500/5/5 A
Accy 0.3 B 0.9
Serial #1077093
Serial #1077094
Serial #1077095

Voltage Transformers

Canadian General Electric (3)
Type E-235Y
Ratio 240/200/180/160/140/120/100/90/80/
70/60 to 1
Serial #1091790
Serial #1091791
Serial #1091792

Calibration Reprots

Voltage Transformers: EC83-440-K, EC83-441-K, EC83-442-K

Current Transformers: EC78-265-K, EC78-266-K, EC78-267-K, EC84-191-K, EC86-235-K